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AUTHOR Reing, Alvin B.
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ABSTRACT

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Imaginal Behavioral Analysis: Multisensory Imagery Scale for Predicting Teacher Competency

Alvin B. Reing, Ph.D.
Associate Professor and
Graduate CRMD Program Advisor
School of Education
Brooklyn College, CUNY
Bedford Avenue and Avenue H
Brooklyn, New York 11210

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Abstract

The study developed and used a self-report graphic Multisensory Imagery Scale (MIS) to analyze imaginal behavior, and to test the hypothesis that multisensory (MS) imagery is a specific teacher competency associated with effective pedagogy, particularly in special education. The MIS was field-tested, abbreviated, performed on teacher-trainees, examined for test-retest reliability, and compared to performance criteria in three successive experiments. Twenty image-evoking phrases of the MIS, cumulatively self-scored for the six sensory areas, yielded consistent imagery responses in agreement with ratings of lesson-plans and teaching. The data defended the hypotheses, indicated the scale's limited usefulness as a criterion for evaluating groups of interns and training programs, and implied support for competency-based teacher education if properly validated.

Imaginal Behavioral Analysis: Multisensory Imagery Scale for Predicting Teacher Competency

Alvin B. Reing, Ph.D.

With the current emphasis upon competency-based teacher education and certification (CBTE/C), posited as a major reform movement in education, the overriding issue remains: "...research on teaching has not been able to turn up such a set of competencies" (Turner, 1975, p. 9). The conceptual underpinnings of CBTE have been questioned (Houston, 1974), as well as the validity and effects of arbitrarily selected lists of teacher-competencies (Brophy & Evertson, 1974). Investigators agree that empirical research is needed to validate pedagogic competencies especially before they are accepted as performance criteria in teacher-internship programs (Shores, Cegella, & Nelson, 1973).

Rosner (1973) also predicted that new materials and measures designed to foster teacher competencies could radically alter all of teacher education, once research justifies CBTE, and monies are committed to such costly programs. Pettigrew (1974) found promise of improved teacher-functioning in multicultural settings, attributable to CBTE. Edgar and Neel (1976) cautioned, however, that a direct functional relationship between teacher behavior and changes in pupil performance has not been empirically verified, to date, because of complex measurement factors. Gillespie and Sitko (1976), in their CBTE/C model, focus on the special education teachers' pivotal position in the decision making process for formulating instructional strategies. Current

studies (Reing, Note 1) continue to search for methods to link specific teacher-teaching behaviors and approaches to the amelioration of learning and social disorders in the retarded.

The present study was conducted to derive, validate, and measure (scale) a specific competency usually associated with the successful teaching of exceptional children--multisensory (MS) ideation. The problem was to relate ideational style of the teacher (i.e., MS imagery and lesson-planning) to an identified pedagogic competency (i.e., MS teaching). It was hypothesized that undergraduate student interns, in a special education sequence of a performance-based teacher-training program, who self-report high MS imagery on a Multisensory Imagery Scale (MIS), also plan and teach MS lessons featuring materials, activities, dialogue, and tasks that afford integrated sensory experiences.

An underlying assumption in diagnostic-prescriptive methodology is that MS (and intersensory) techniques, matched to modality needs of pupils, help to alleviate or circumvent specific learning disabilities (Clinger & Van Osdol, 1974; Myklebust,1973; Smith, 1974, pp.144-153). The individualized methods of currently used special education curricula stress intersensory approaches to learning (Frostig & Horne, 1964; Valett, 1974). Frostig and Maslow (1973,pp.22-25), summarizing the findings of educators and neuropsychologists, advocate a MS approach for all classrooms as a means to increase positive

transfer through response generalization and differentiation. However, as reviewed by Hammill and Bartel (1975,pp.229-230), perceptual motor programs currently in vogue have not been consistently supported by investigative data, except when studies employed 20 or more experimental subjects, matched control groups, and a training period exceeding 15 weeks. MS techniques and programs, more comprehensive curricular approaches that include perceptual-motor strategies, have also produced significant improvement in retarded pupils' skills under these conditions (Reing, Note 1).

Prior research by the investigator (Reing, Note 2), in addition, has shown that increased MS organization and functioning, in student teachers assigned to mentally retarded (MR) and learning disabled (LD) children, evidenced by greater spontaneity and animation during observed interactions with pupils, improves their task-analytic skills and ability to identify and remediate learning and behavioral difficulties. In other studies, MS planning and teaching by CBTE students interning in socio-recreational and tutorial programs have been found to enhance their MS imagery (Reing, 1976b), and to ameliorate nondevelopmental dyscalculia in their pupils (Reing, 1976a).

To date, however, research that attempts to isolate and measure the specific teacher-competence of MS ideation, and directly relate it to MS planning and teaching, has not been reported. The

present study, therefore, was generated by (a) the general need to identify and field-test at least one teacher-competence of the many claimed taught by CBTE/C programs, and (b) the specific need to quantify the imaginal behaviors associated with MS imagery as a personality variable of competent teaching.

MS imagery, on the verbal construct level, is affective ideational behavior that mediates between words presented and words evoked. The imaging process in the individual produces concrete images distinguished according to their singular or composite sensory quality, contrasted with verbal images representing either an object or a past speech experience in verbal terms. In either case, ideation can be self-reported in the form of words that denote and/or connote imagined affective responses conjured by other words that represent or describe objects and events. Imageless thought which is non-sensory if it occurs cannot be directly reported or measured (Johnson-Laird, 1974), while imagery that conveys concrete (sensory) images, in response to and expressed as words, constitutes observable behavior that can be manipulated and measured (scaled).

The image-evoking potential of words orally or silently read has been investigated by Bugelski(1962), and Bower and Clark (1969). Paivio (1969) found a difference of six magnitudes in favor of an imagery treatment for word lists. Yuille (1968) showed imagery to be a more effective criterion than concreteness in word-learning. Paivio, Yuille, and Madigan(1968) developed a list of 925 nouns scaled for imagery, concreteness, and meaningfulness, on which the words that aroused the quickest and easiest

mental images were assigned high imagery ratings. Applying that procedure, Van der Veur (1975) studied 1000 words, including all parts of speech, and concluded that the imagery rating of words was related to ability of beginning readers to read them.

Pressley (1976) obtained evidence that practice in constructing mental images improved the ability of eight-year-old normals to recall stories read. Undergraduates, reading more vivid versions of paragraphs, have also indicated higher recall related to increased imagery (Montague & Carter, 1973). However, Taylor, Josberger, and Whitely (1973), studying the effects of elaboration instruction and overt verbalization on recall in young educable retardates, found that imagery training was not more effective than sentence elaboration. Zupnick and Meyer (1975), investigating the long-term effectiveness of imagery instruction with similar subjects, concluded that the method facilitated only short-term learning and retention efficiency. Nelson (1976), comparing the concomitant effects of visual, motor, and verbal experiences in the concept attainment of young normals, showed that verbal-and-motor training combinative methods were the most ameliorative.

These findings regarding MS pedagogy, carefully analyzed, provide equivocal defense for generalizing the value of sensory stimulation methods to all learners and settings. As indicated by Zigler and Seitz(1975), in reviewing the efficacy of sensorimotor patterning (Neman, Roos, McCann, Menolascino, & Heal, 1975), treatment rationale, subject selection, procedure, statistical analysis, and interpretation of findings continue to be

inconsistent factors in such research. The present investigator, after an exhaustive search of studies relating MS teacher-and-teaching to learning, concluded that (a) sensorimotor approaches, if not meaningfully incorporated into general MS curricula stressing long-term personal and social adjustment goals, produce limited if nonsignificant gains, and (b) assessment procedures used tend to be neither task-specific nor relevant, or obscure the imagery behaviors inherent in teacher- learner interaction (Postman, 1975, pp. 372-323).

When studies were reviewed, relating modality preference (i.e., imaginal mode or ideational style) to performance, limitations in imagery measurement and generalizability of samples and settings accounted for many of the discrepant findings. Waugh (1973) found that auditory learners performed equally well on auditory and visual tasks, while visile pupils did not excel on visual tasks; he posited that imaginal preference stressed in teaching fails to facilitate word recognition and recall. Support for multimodal (multisensory) methods, stressing all rather than simple or combinative input channels, was provided by Reing's investigations of the effects and treatment of specific visual-perceptual dysfunction in (a) dyslexic and dyscalculic normals prone to heterozygous sicklemia and thalassemia (1975a; 1976a), (b) learning-disabled normals (1975b), and (c) educable and trainable retardates (1974a; 1976b) in school and community programs.

Investigations of imaginal style unrelated to pedagogy or exceptionality, when thoroughly reviewed, revealed considerable defense of the importance of the imagining process to perception, cognition, and affective behavior, but frequent disagreement in operationalizing and measuring the construct. Khatena (1975) showed that vividness of visual, tactile, and auditory imagery was related to creative self-perceptions, by testing undergraduates on the Betts Visual Imagery Scale (Questionnaire upon Mental Imagery). Betts' scale (QMI), and the Sophian Scale of Imagery and Scale of Internal Perception, contain sensory modality items as does Reing's MIS (see Figure 1), but structure different instructional sets and imaginal items, and measure responses unimodally. For example, the original version of the

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Insert Figure 1 about here

QMI contained 150 items: 40 visual, 20 auditory, 20 cutaneous, 20 kinesthetic, 20 gustatory, 20 olfactory, and 10 organic items, the last category a seventh modality of questionable construct validity. A different series of single and multi-word items was presented for each sensory mode, in a 30-page booklet requiring 55 minutes to complete. Separate scores were tallied for each modality, and a preferred orientation obtained. Sheehan's (1967) abbreviated form of the QVI comprised just five items from each of the seven original lists, but also yielded only unimodal scores, and indistinguishable "imagery types", according

to the research findings.

In a recent investigation of ideational styles, Ashton and White (1975) examined the effects of neutral, low, and high motivating instructions on undergraduates' performance on the revised QMI, and found that responses were contaminated by a perceived desirability of claiming intense images. (On the differently structured MIS, respondents consistently report no such predisposing value judgments.) Honorton (1975) questioned the construct validity of the QMI, and claimed that the scale needs corroborative subjective, behavioral, and psychophysiological data. (The MIS is highly correlated to presumed effects on planning and teaching criteria). Ikeda and Hirai (1976) similarly disputed the efficacy of the Sophian scales, and reported that individual differences in subjects' self-control of autonomic electrodermal activity affected imagery responses.

However, in studies involving manipulative treatments and varied but specific learning tasks, imagery facilitated performance on word-recall (Gumenik, 1976), mnemonic memory (Senter & Hoffman, 1976; Tharp, 1972), complex coding (Wittrock & Goldberg, 1975), synchronic thinking (Paivio,1975), and even personality and behavior changes (Panagiotov & Sheihk, 1974). An innovative methodology for individual and group psychotherapy, clinical eidetics, employing imagery to reveal and resolve conflict areas, has been generated (Ahsen, 1977). The psychophysical effects of imagery mediated by instructional sets on parasympathetic reactions (Ikeda & Hirai, 1976), and heart rate and

muscle tension, but not respiration rate (Beiman,1976) have also been evidenced.

In summary, prior investigators have successfully developed and applied different imagery models within the context of word retention, memory, and coding tasks, and verbalized thinking and affective behaviors, concur on the need for more specifically valid and reliable imagery measures correlated to performance, yet conflict in interpreting the criterion effects of the imagery construct. Thus, Postman (1975) insists the principle thrust of further research should be to resolve the divisive issue of how to construe the effects of imaginal activity.

Accordingly, antecedent studies have demonstrated the usefulness of imagery rating, and that different words and phrases educe images varying in degree of imagery, concreteness, and meaningfulness. Therefore, reflecting these findings and recommendations, the purpose of the present investigation was to scale cumulative differences in spontaneous responsivity to image-evoking phrases, permitting the self-reporting of multiple rather than unimodal ideational responses, in order to relate the effects of imagery directly to interpretable behavior--the specific pedagogic competence of MS planning and teaching.

Scale and Revisions

MS imagery is operationally defined as ideational or imaginal behavior involving most or all six sense modalities (i.e., visual, audityory, olfactory, tactual, gustatory, and kinesthetic), expressed as spontaneous responses on a graphic linear self-rating

scale. Accordingly, the higher the reported imagery response set, quantified from cumulative sensory reactions "imagined" by the subject, the higher is his/her MS imagery score. High scores were posited to be linked to MS planning and teaching--a specific teacher-competence regarded as pivotal to the efficacious teaching of MR and LD children (Smith, 1970,pp.77-111).

The current research developed and field-tested the MIS, the first page of which appears in Figure 1. In addition to the two specimen items and initial two phrases shown, the remaining 18 items, repeating the same response format, are (3) screeching chalk, (4) mustard on the shag rug, (5) ice cube down the back, (6) head of a rotting fish, (7) candle flame in the dark, (8) fly swimming in the coffee, (9) piece of glass in the boiled spinach, (10) ice cream on a meatball, (11) elbow on a hot radiator, (12) pebble in the shoe, (13) burnt cinnamon toast, (14) freshly mowed grass, (15) snowball in the face, (16) rubbing alcohol spilled on the floor, (17) burning, smoking rubber tire, (18) silver dollar in the mud, (19) vomit on the bus seat, and (20) worm in the bitten apple.

The MIS, in its original form, was a revision of Reing's (1970) adaptation ofthe Griffitts Test of Concrete Imagery (GTCI). In Table 1, the three successive scales, the GTCI,

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Insert Table 1 about here

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the GTCI revised, and the MIS are listed for comparison, showing number, format, presentation and timing of items, and type and scoring of responses.

For the GTCI, the examiner read aloud 125 words or brief phrases, to which the subjects immediately responded by writing down the sensory mode of their first image. In the revised version (Reing, 1970) , the examiner read aloud the same items, but subjects were asked to self-report first images as relatively visual or non-visual on a numerical 5-point scale. The modified scale correlated highly to the original GTCI, r=+.95, $p < .01$, when both tests were administered four months apart to 50 normal urban adolescents.

Schlaegel (1953) first cross-validated Griffitts' scale on 67 blind and 78 matched sighted adolescents, and found visual imagery to be their dominant mode, t = 6.90 and 7.43, $p < .05$. When Reing (1970) applied the revised GTCI to 212 urban adolescents, following psychoeducational treatment by oculomotor conditioning and/or perceptual training for specific visual-perceptual dysfunction (i.e., incipient HDSA: hyperopic-diplopic pre-strabismic amblyopia exanopsia), he found it to be able to reflect improved visual ideation and reduced psychomotor impulsivity, F = 13.37, $p < .01$.

The revised GTCI was subsequently performed on 68 undergraduate and graduate special education majors (Reing, 1974b).. They were then asked to revise the scale by selecting, and changing if they prefer, 20 items from the list of 125 that best sampled their total responses. The revised 20-item list was presented

to the entire group four months later, to reduce the effects of memory, read silently, and graphically self-scored by each student. The results were then compared to the original full-length, orally presented version with different but parallel items. Accordingly, a Pearson product-moment coefficient of correlation of +.91, $p < .01$, was obtained for the two sets of data, thus defending the abbreviated form.

Next (Reing, 1975b), 32 teachers in a graduate special education program were administered the revised GTCI, and four months later, the MIS. When the data were compared by the Pearson product-moment formula, a correlation coefficient of .82, $p < .01$, was found. After taking the MIS, the teachers were asked to indicate reactions to the two forms. Almost unanimously, 96.8% indicated preference for the revised, abbreviated scale because (a) the MIS requires only 15-25 minutes to complete, (b) the items are often amusing and elicit more spontaneous imaginal responses, (c) the subject proceeds at his/her own silent reading rate, and can return to items to modify answers, not possible in the longer orally-presented revised GTVI, (d) the subject still graphically registers his/her own responses, but by drawing different lengths of lines for each item, rather than indicating a simple forced choice, from 5 to 0, varyingly visual to non-visual for each item as in the preceding version, and (e) the directions do not suggest the scoring method to be used(all responses are appropriate) nor consciously influence the testee to perceive a desired modality pattern that would bias answers.

The scales, subjects, methods, and data summarizing the results of the 12 different administrations, are listed in Table 2.

Insert Table 2 about here

Present Scale. In its present form, the MIS is an untimed ipsative graphic report scale of 20 consecutive items that can be individually or group administered.[1] Its descriptive phases are designed to elicit as many immediate (spontaneous) linear responses as possible in the six sensory areas commonly emphasized in perceptomotor strategies for exceptional learners. Directions and two specimen items are first orally presented by the tester (see Figure 1). The subject is also asked to read the directions and sample questions provided, and then react to them by drawing a straight horizontal line across the 11 possible spaces (0-10), indicating the strength of his/her imagined response along a none-average-intense continuum. He/she is told that there are no expected, desired, or model responses--all are appropriate.

Scoring. Each modality area is scored by totaling the linear lengths, or number of spaces traversed by the student. Since the MIS comprises 20 items, each divided into six modalities with linear values from 1 to 10, a total perfect MS score would be 20 X 6 X 10 = 1200, ÷120, or 100. However, as revealed by a

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[1] Copies (i.e., specimen set, $.75 each, or 25 for $8.75, plus 8% sales tax, and $.75 postage and handling charges) may be obtained directly from the author: Alvin B. Reing PhD, Brooklyn College, CUNY, School of Education, Bedford Avenue and Avenue H, Brooklyn, New York 1121

visual examination of the items and possible modality choices, zero(0) responses in several instances are unavoidable for irrevelant matches. This "built-in" scoring feature of the scale imparts a 6-modality continuum consistent for all items, and provides a planful check against random or deliberately high scores. The testee thus usually perceives, from the directions and item structure, that separate sensory modal scores are computed, not a single MS total, the actual scoring method. Nonetheless, the frequent control items are needed (i.e., 1b and e; 2b, 3c and e; 4b; 5b,c, and e; 6b; 7e; 8d, e; 9b; 10b; 11c and e; 12b and e; 13b; 14b; 15c; 16e; 18b,c, and e; 19b; 20b).

Consequently, as revealed by score distributions for the MIS, a perfect total, with the indicated corrections, is possibly 750, not 1200. The MIS data so far obtained for different groups show that approximately 12 (2%) of 589 undergraduate and graduate students have achieved total MS scores in the 700-748 range (mean = 724). The cumulative frequencies, proportions and percentages for the MIS to date are shown in Table 3 and ogive curve in Figure 2. Consequently, until more findings are obtained,

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Insert Table 3 and Figure 2 about here

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a multiplier of .138 is applied to the total raw score to convert it to a convenient adjusted score (e.g., 724 X .138= 99.9) with a familiar range of 0 - 100 (i.e., mean raw score of 485, mean adjusted score of 66.95, standard deviation of 10.67, and standard

error of the mean of .44, for all 589 subjects rated to date, including 269 in the present three experiments.

The MIS can be self-scored by the testees themselves, or afterwards, by computer. However, if a test-retest method is planned, as in the present research, the totals cannot be computed by the subjects themselves, because the desirability of a high cumulative (MS) score would be readily perceived, and affect retest responses. But, when the scale is used as a one-shot, limited assessment procedure, the students can tally and compute their own scores, and discuss their meaning and possible predictive value with instructors and counselors.

In the present research, further standardization of the instrument was undertaken. The MIS was field-tested in order to determine sex differences in response patterns, and its ability to reflect changes in MS ratings and behavior correlated to performance criteria, attributable to a specific CBTE/C program stressing MS methodology.

Experiment 1

Experiment I was conducted to test the hypothesis that male and female interns in an undergraduate CBTE/C program, with a special education emphasis, indicate similar MIS scores. Consequently, if sex does not discriminate MS patterns, different male-female versions of the scale would be unnecessary , and pooled group data could be used to evaluate posttreatment effects.

Method

Subjects. The sample consisted of 63 sophomores in a major urban college, enrolled in a CBTE/C program for training prospective special education teachers. In compliance with school policy, the class was divided randomly in three sections, and assigned to three available schools in similar neighborhoods with similar clusters of mentally retarded and normal classes in order to equate internship experiences. During the 15-week semester, all trainees received 60 hours of field experience in classrooms, and 60 hours of lecture and workshop sessions. No attrition occurred, for all maintained satisfactory to excellent scholarship and performance records. Only 16 were males; ages ranged from 18 to 23, $\underline{M}$= 19.6. Forty-seven were females; ages ranged from 17 to 23, $\underline{M}$= 19.3. The 16:43 ratio, male to female, reflected the program's preponderant number of female students evidencing interest in an elementary education sequence of courses. Prior imagery research, however, had not hypothesized a sex criterion for imageability, so that so far, only a single form of the MIS has been developed and used.

Procedure. On the first day of the course, the three sections convened as one class. After an introductory overview of the program, and discussion to establish rapport, the instructor distributed the MIS forms that had been previously approved by college administrators, and explained:

"This is a rating scale that shows how you think. It records the senses you imagine you use in response to scenes

described to you as you read. There are no right or wrong or best answers. (At the end of the course, you will fill out the same form again. At both times)[1] you score yourselves to see which ways you do most of your imagining--seeing, hearing, smelling, feeling or touching, tasting, or moving. Thus you can learn more about yourselves, (the first step to learning more about the children you teach)[2]."

The students completed the forms at their own rate, so that by the end of 15 minutes, they had all been returned. Since the oral and written instructions were simple and clear, all the students were able to use the scale without having to ask any questions that might have interrupted and contaminated their spontaneous flow of responses.

The purpose of the first experiment, as stated, was only to assess sex differences on the MIS. Consequently, the design provided a comparison between male and female students' ratings on the first administration of the scale, on the first day of class, when presumably, students were equated on experience, motivation, and training. The testees were not told the scale would be repeated. Moreover, the completed forms were collected, and not discussed further in class, which would have biased retest responses. The students did not score their papers, or others', on either administration of the MIS.

Results

The adjusted MS scores (i.e., totals of all items and

[1]In a test-retest application of the MIS, as in Experiment 1, the examiner reads aloud this entire paragraph to the students before they read the directions (see Figure 1). This parenthesized section is omitted if no retests are planned.

[2]Omit also, if inappropriate for tests and/or retests.

senses X .138) of the 16 male students produced a mean of 65.06, a standard deviation of 3.47, and a standard error of the mean of .897. The adjusted MS scores of the 47 female students yielded a mean of 62.11, a standard deviation of 11.26, and a standard error of the mean of 1.642. The standard error of difference between the two means was 2.91, which was found to be nonsignificant, using a two-tailed test, t (61) = 1.017, $p > .01$ (see Table 4).

Insert Table 4 about here

As a result, the adjusted MIS scores for male and female students were shown not to be significantly different, and justified computation and use of composite scale scores, which were determined to have a mean of 62.86, a standard deviation of 9.96, and a standard error of the mean of 1.265 (see Table 3). It was therefore concluded that for the subjects, setting, imagery criterion, and CBTE/C purposes stated, the MIS failed to discriminate respondents on sex--a further step in the scale's standardization. However, the problem whether separate but parallel male and female forms of the scale should be developed and standardized, on the dubious premise that interactive socio-cultural and biogenetic factors differentiate the sexes imaginally as well as psychophysically, requires further investigation with larger samples in varied settings.

Experiment 2

Next, experiment 2, the second phase of the investigation, was conducted to test the hypothesis that the MIS, correlated to performance criteria (i.e., MS lesson planning and teaching), reflects improved MS imagery, resulting from a specific MS lecture-and-field program.

Method

Subjects. The same sample was used as in the first experiment. The setting and related factors were also the same. The investigator's purpose was to obtain MIS retest data on the same group, to compare them with the first scale findings. As indicated, the 63 sophomores were randomly divided and assigned to three different but matched schools, to ensure 15 consecutive weeks of equivalent training and experience.

Procedure. The course stressed introduction to special education, philosophy and general principles, and basic foundations in lecture (60 hours), and provided introductory observational and limited tutorial experiences in classrooms for normal as well as handicapped elementary school children, for the same number of hours. The CBTE/C program listed many specific competences in knowledges and skills that the teacher-interns were expected to satisfy as a result of the course.

At the beginning of the final (fifteenth) session, the MIS was distributed to the same students convening as one class, as for the initial session when the scale was administered. The same procedures as in the first experiment regarding subjects, directions, instrument, setting, timing, and scoring, were applied. The test-retest method required an interval of nearly

five months, considered neither too short, which would permit the students to recall items and responses, nor too long, which would intrcduce interactive maturational and experiential factors. Besides, the permuted possibilities of graphic choices (i.e., 20 items X 6 sensory modes X 10 linear scale units) obviate any significant recall.

To provide systematic evaluation of MS lesson plans, and to correlate MIS scores to performance criteria, the study employed the Multisensory Math Lesson Plan evaluation form (MLP) developed by the investigator (Reing, Note 2) as a standardized competence-based rating method for the college. The instrument, presented entirely in Figure 3, comprises a list of 20 pedagogic MS

Insert Figure 3 about here

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criteria. The instructor rates the trainee on each item, from 0 for no evidence of MS lesson-planning, to 5 for consistently outstanding performance, so that conceivably, a perfect score would be 20 X 5 = 100. In addition, a total MS score may be obtained and averaged for a mean score. In the second experiment, the scale was utilized to evaluate lesson plans, submitted near the end of the course, covering all instructional areas related to math.

To quantify assessment of actual teaching of MS lessons, and further, to correlate MIS and performance data, the study used

the Multisensory Math Teaching evaluation form (MMT) also developed by the investigator (Reing, Note 2). The MMT, presented

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Insert Figure 4 about here

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in Figure 4, consists of 20 items commonly used by special education supervisors in the school system to evaluate teaching. The items on both the MLP and MMT forms are of parallel construction. Following each of two 7-week classroom assignments, the intern's "resource" (assigned) teacher evaluated his/her tutorial and teaching performance by means of the MMT. The course instructors blind-rated the five lesson plans of each trainee on the MLP at the end of the course, without knowing the student's classroom assignments, identity, and MMT data. Similarly, the "resource" teacher rated actual teaching performance without access to MLP data.

As planned, if analysis of the MIS data would show significantly higher retest performance, following MS instruction and training, then the scale's predictive value could be demonstrated. Also, if the posttreatment MLP and MMT findings correlated highly to the MIS, the three scale scores could be combined, and justifiably used to evaluate the effects of specific MS training methods for teacher-interns, as in the subsequent experiment.

Results

The total (i.e., items and senses) adjusted MS scores of all 63 students on the MIS retest yielded a mean of 75.14, a

standard deviation of 6.49, and a standard error of the mean of .824. In order to compare the findings with the results of the first administration of the scale in experiment 1, already indicated, a two-way classification analysis of variance was performed on the data (see Table 5). A significant difference was found, F (1,124) = 66.19, $p < .001$, indicating that the

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Insert Table 5 about here

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instrument was able to reflect the effects of the treatment, producing higher MS imagery scores as predicted. When a Scheffé analysis of the test-retest means was performed, a significant difference was also obtained, t (124) = 8.13, $p < .001$ (see Table 6).

Insert Table 6 about here

Following the MIS retest, and analysis of variance procedure, the individual MS scores were rank ordered from high to low, as were the trainees' MLP and MMT scores, obtained as indicated. Then, a coefficient of concordance, Kendall's W, was performed on all three ranks, using chi square as required for large samples (Siegel, 1956, pp.231-237). A W of .81, $p < .01$, was therefore found, showing that the MIS, an ideational self-report scale, was in high agreement with the MLP and MMT performance scales, rated by independent observors (i.e., course instructors and resource teachers), in ranking students on MS imagery.

Accordingly, the finding defended the use of a combinative (i.e., MIS + MLP + MMT, 1:1:1) procedure for evaluating MS imagery and performances as a single teacher competence, of far greater applicability than separate use of the scales (Johnson-Laird, 1974, p.151).

The design of the experiment and nature of the instruments necessitated the use of a parametric (i.e., analysis of variance) statistic for a test-retest MIS comparison, and a nonparametric (i.e., Kendell's W) procedure for determining concordance of all three scales. The teacher-intern sample was considered representative of the heterogeneous population of education majors, and the field settings and instructional experiences were regarded as usual for such major urban undergraduate programs. However, the instruments themselves had previously not been used together, and only the MIS had been subjected to experimental standardization (see Table 2). Furthermore, the assumption underlying the use of a parametric statistic for judging ranking or ordering instruments, that the scores are truly numerical and additive (Siegel, 1956, p.3) was not satisfied, at least by the MLP and MMT instruments, whose intertest reliability had not yet been established.

Experiment 3

Following the first two experiments, the investigator conducted a third study (Reing, 1976b) in order to resolve issues raised by previous findings, and to standardize further the

instrument by correlating MS imagery ratings to performance criteria. In the second test-retest experiment, no attempt was made to provide a control group, matched to the experimental subjects, in order to relate the significant improvement in MIS scores on the retest to the effects of intervening CBTE/C treatment. For, its purpose was to demonstrate the instrument's test-retest reliability, and to validate its claimed predictive value (Waugh, 1973).

Method

Subjects. The subjects were 80 college sophomore teacher-interns (trainees) in a CBTE/C program in special education (CA 18-24; $\underline{M}$ = 19.8). Of this group, 40 were randomly assigned, from a randomized list of names, to an elementary school in which they received ordinary supervision and internship experiences. The remaining 40, randomly selected and matched by age and sex, were assigned to a similar school comprising comparable neighborhoods, pupils, and teachers. Supervision and internship experiences for the second group was specifically task-analytic, for the same period of time--14 weeks, one day a week, for three hours.

Task-analysis (TA) is the diagnostic-prescriptive method used by teachers to identify the component errors of specific behavior, and systematically correct and restructure the sequence by matching strategies and stressing strengths to remediate or circumvent deficiencies (Reing, 1976b). The TA viewpoint differs from the specific ability-training model in assumptions and methods, as delineated by Ysseldyke and Salvia (1974). TA

emphasizes the integration of subordinate skills into complex terminal behaviors rather than the training of processes, identified by tests, linked to skill development. TA depends on component observation and "clinical" teaching, while the latter diagnostic-prescriptive model is based on evaluations by tests of questionable concurrent and predictive validity for exceptional learners.

In the third experiment, trainees in both schools interned (i.e., observed and tutored) in special education classrooms for seven weeks, and in regular classrooms for seven weeks, as required by the CBTE/C program, in order to balance course experiences. Forty volunteers from the 80, 20 from each of the two schools, also participated in an intensive individualized TA training experience: an experimental bowling program for MR children. Each session lasted three hours, one day a week, for a total of five weeks (i.e., 15 hours, in 3-hour non-consecutive blocks). Randomized blocking provided equivalent training and experiences. Interns were rewarded for non-paid participation with letters of recognition from school supervisors, intrinsic satisfaction derived from assisting handicapped children, and professional growth through intensive TA training. Because the 40 volunteers were those teacher-trainees who were free of course or job obligations on bowling days, they were assumed not motivationally or academically different from the remaining 40 subjects.

Design. A posttest-only control group design, with a 2 X 2 factorial analysis of variance (ANOVA) and Scheffé tests, was used, justified because subjects and treatments were randomly

selected and assigned. The experimental groups, without pre-testing, were thus unaware that their performances and behaviors would be measured and compared. Also, a practice effect was avoided. The retarded children were involved in the program in order to have fun, learn a skill, and improve in mathematics. These were 75 trainable (25 -49 IQ) and educable (50-75 IQ) retardates, ages 8-16, from two cooperating schools, replaced every other week by a similar number of matched children from two other schools. Thus, a total of about 300 handicapped children were serviced by the bowling program. The same 40 teacher-intern volunteers, however, participated in the activities only for a total of five sessions during the program's 16-consecutive weeks concurrent with their college semester.

Treatment groups. Of the 40 teacher-interns given TA lecture-and-classroom training (TL) in their math course (i.e., one hour of lecture and three hours of classroom performance for 14 weeks), 20 were also in the bowling program (group BTL) while the 20 in group TL were not. Of the 40 others given ordinary but non-TA pedagogical training in the same college program (i.e., same number as TL), 20 were also in the bowling program (group BT) while 20 were not (Group L). Therefore, the interaction group (BTL) of 20 interns received TA training through combined lecture and classroom experience as well as bowling. The 20 subjects in BT received TA training through bowling only. The 20 in TL received such training through lecture and classroom experience only. However, control group L received no special TA instruction, only ordinary lecture and classroom intervention. Since the program was tied-in with the math course, attrition was controlled and did not occur.

Hypotheses. It was predicted that (a) teacher-interns receiving interactive training (BTL) would improve more on the criterion measures than those in groups BT, TL, or L, and (b) trainees in BT and TL would experience equal improvement in MS ideation, math lesson-planning, and teaching, and surpass group L (i.e., BTL > BT= TL>L).

Variables and instruments. The experimental variable was TA training presented as TL, BT, or BTL in the interaction design. The effect variables were the interns' (a) MS ideational style as measured by the MIS (see Figure 1), (b) five MS math lesson plans evaluated criterially on the MLP (see Figure 3) by independent expert judges, and (c) MS mathematics teaching evaluated by assigned classroom teachers using the MMT (see Figure 4).

The treatment effects of the BT and TL procedures were postulated because trainees in both groups were scheduled to receive the same content and amount of task-analytic training whether in the classroom setting or in the bowling alley. For a total of 15 hours over five staggered sessions, they were randomly assigned to teacher-trainers and retarded pupils, and taught diagnostic-prescriptive movement methods through specific example and supervised TA experience.

Results

The direct versus interactive effects were factorially investigated in order to compare the study's contrasting treatment methods: TA lecture-and-classroom training (TL), or TA training through bowling alone (BT), or their interaction (BTl). Since the purpose was not to obtain separate criterion measures to compare

their diagnostic value, a single composite score for each trainee was obtained from the three instruments, a procedure demonstrated feasible in the previous experiments. The posttreatment data were then assessed by a 2 X 2 factorial ANOVA, examined first in their originally arranged order, and next in their rearranged position in order to control for their order of treatment. One-tailed F tests were used with critical values for the stated .01 points, and then Scheffé tests, to test for the significance of mean differences.

Findings.

The study's three instruments (i.e., MIS, MLP, and MMT) produced a single composite MS score for each teacher-intern, a procedure defended in the preceding experiment. As previously noted, the raw mean score of 500, adjusted by a multiplier of .138, produced a mean adjusted score of 69, and a high coefficient of concordance ($W = .81$, $p < .01$) with the performance scale scores, in a 1:1:1 ratio. The MLP and MMT scales, as described, each yields a possible total optimal score of 100, the same as the adjusted MIS maximum. Accordingly, the combinative score for the three scales, considered additive, was their arithmetic average (i.e., adjusted MIS + MLP + MMT totals ÷ 3).

In the third experiment, the combined average posttest scores, treated by the factorial of variance, indicated that the main effects of TA training, by means of either lecture and performance or bowling, were significant, F (1,76) = 23.09,

and 53.80, $p < .01$, respectively. However, analysis of the treatment data for interaction group BTL showed the effects to be nonsignificant, F (1,76) = 3.13, $p > .01$ (see Table 7). But,

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Insert Table 7 about here

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when the order of means was reversed, factorial analysis of the lecture and performance method indicated no significant effects, F (1,76) = 3.13, $p < .01$, whereas the effects of bowling and BTL interaction were both found to be significant, F (1,76) = 52.80, and 23.09, $p < .01$, respectively.

Scheffé tests were next performed to examine the differences between the means (see Table 8), since their order of appearance

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Insert Table 8 about here

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affected the F ratios, as demonstrated. Accordingly, the mean differences between treatments (and groups) BTL and L, BT and L, and TL and L were shown to be significant in descending order, t (76) = 8.63, 6.48, and 4.68, $p < .01$ (see Table 9). Also, the Scheffé analysis indicated the mean differences between BTL and

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Insert Table 9 about here

TL to be significant, t (76) = 3.96, $p < .05$. Thus, the findings revealed a descending order of effects, BTL > BT > TL > L, instead

of the predicted outcome: BTL > BT = TL > L.

Discussion

The results of the third experiment did not consistently defend the study's predictions when the means in their original and reversed orders were examined by the factorial ANOVA method. But, when the Scheffé tests were used, the results generally provided support for the first hypothesis: interactive treatment (BTL) increased MS ideation, planning, and teaching more than BT or TL, respectively, while the main and interactive treatments all exceeded those of L. The Scheffé test data, however, failed to defend the second hypothesis. For, while TA training through interactive lecture, classroom, and bowling experiences yielded the most improvement, BT treatment equaled TL's effects, rather than exceeded them as predicted.

Accordingly, the findings indicated that the interactive BTL method was the most effective. But, TA training through bowling alone was almost as ameliorative, and more so than such training through a lecture-and-classroom approach without bowling. Therefore, the evidence underscored the value of a field-based, individualized training method over a longer, more costly traditional TL method, if the choice has to be made. However, the BTL method, shown to produce superior results, would incur the expense only of the college supervisor's services, since the entire program was staffed by unpaid volunteers, and teachers and other personnel who were paid by the school system for the day anyway, and funded by both the bowling alley and a charitable organization--

readily available community resources (Reing, Note 3).

Implications for CBTE/C

The study also satisfied a critical need in the expanding field of undergraduate CBTE/C: the experimental validation of specific competences (i.e., diagnostic-prescriptive skills). The effects of TA training, through an active clinical-teaching procedure (bowling) and/or less participatory lecture-and-classroom method, on specific behaviors essential to special educators (i.e., MS ideation, planning, and teaching), were directly observed and measured.

The data, in general, showed that TA training, whether by means of a supplementary socio-recreational program, or lecture and classroom instruction and performance, or their interaction, surpassed ordinary performance-based training in producing a diagnostic-prescriptive competence important for prospective special education teachers. The results suggested experimental application of such approaches to other teacher-training programs involving more, less, or non-handicapped pupil populations.

The investigation was limited by the number of college sophomores who could participate, the number and length of sessions possible, and the schools, pupils, and teachers available and able to be included. Also, only the competence of TA teaching was sampled and explored, in their measured effects on MS imagery, planning, and teaching, as revealed by the MIS, MLP, and MMT scales used combinatively. The whole spectrum of

teacher-and-teaching behaviors surmised to constitute competent pedagogy demands identification and systematic investigation to validate CBTE/C.

In the process, as the experiment demonstrated, gains in skills and fun for the children themselves alone justified the bowling program. Objectives of the Mathematics-Core curriculum (i.e., skills in computation, problem-solving, and proper use of quantitative and qualitative language), and environmental training curriculum (i.e., self-care and socio-recreational skills) concurrently stressed in the schools and undergraduate courses were achieved, as indicated by subsequent school reports. The children, parents, teachers, and communities were directly serviced through a cooperative school-and-community effort. Besides increasing their social and computational skills, the retarded pupils learned to develop an important recreational outlet for future life adjustment (Reing, Note 2).

Implications for Imagery Research

The results supported the hypothesis that trainees who self-report high MS imagery also plan and teach MS lessons. The findings demonstrated that the MIS reliably analyzes imaginal behavior, and defends its use as a practical and reliable instrument that concurs with performance data in assessing the specific competence of MS pedagogy. In special education in particular, high MS imagery is associated with effective teaching (Frostig & Maslow, 1974, pp. 22-23). Furthermore, Goldberg (1974) has shown that illustration by imagery facilitates the

retention of incidental learning in normal classrooms, as well.

The study's development and field-testing of an easily administered and scored reliable scale to identify and measure a specific teacher competence also should contribute to validating CBTE/C as urged by investigators (Brophy & Evertson, 1974; Houston, 1974). A single instance of support, however, does not constitute a universe of findings, especially since only major urban special education teacher-trainees in one performance based program comprised the two samples for the three experiments. Besides, so far, only the present investigator has experimentally linked high MS imagery to effective planning and teaching of handicapped children (Reing, Note 1, Note 2).

Extensive field-testing of the MIS, with trainees and examiners from varied programs and settings, including regular education majors in normal as well as exceptional classrooms, is needed before relevant norms and wide applicability can be claimed (Johnson-Laird, 1974, p. 151). The data reflected content and concurrent validities, not construct or predictive criteria. Therefore, the scale cannot, and was not intended to replace a well-balanced depthful review of scholastic, experiential, and attitudinal-motivational data in screening applicants for a CBTE program emphasizing special education, or to rate trainees' progress or predict success. Its value instead lies in assisting instructors in analyzing group ideational characteristics so that training strategies may add or further stress spontaneous MS planning and teaching, if the need is suggested.

The correlation of the MIS to performance data, in this study, nonetheless lends support to the findings of investigations of imagery theory (Paivio, Yuille, & Madigan, 1968), the image-evoking potential of words (Bower & Clark, 1969), and their facilitating effect on learning (Goldberg, 1974). The present research extended the imagery rating of words by van der Veur (1975) to the multimodal MS rating of phrases, by use of an abbreviated graphic self-report scale, and linked imaginal activity to interpretable behavioral affects (i.e., on prospective and practicing teachers), as urged by Postman (1975, p. 323).

Consequently, the results suggest implications for future research and applied practice in teaching. As stated, high MS imagery (scores) were correlated to high MS planning and teaching performance (effects), thereby supporting the conceptualization of imagery as the encoding of propositions effective for storage and application as well. Accordingly, MS imagery predisposes the teacher to plan and teach in a characteristic manner, and high MS ratings predict such behavior as a competence essential for successful pedagogy. The subjective experience of images, therefore, does not "cause" associative behavior, but rather leads to assemblies of words and "mind's eye" pictures, coded metaphors of possible actions that complex situational conditions and personality states may interactively trigger.

Furthermore, the research raises issues about the very measurability of the imagery construct. MS behaviors (i.e., lesson

plans and teaching) were only linked to MS scale values, not causally established. However, if a preferential or prevalent modality orientation can be properly identified and reinforced in teachers and pupils, under varied matching (MS vs. unimodal) conditions, the experimental effects on learners and learning can be analyzed, to justify deliberately structured MS methods, materials, and environments. Also, if imaginal modes are reliable predictors of behavior and performance, though questioned by Waugh (1973) and Pylyshyn (1973), then interrelations among teacher and student modality styles and teacher competence(s) can be explored by manipulating techniques and strategies, and the findings generalized to a variety of programs and settings.

A serious limitation to such proposed studies continues to be the construct validity of the imagery criterion. The present investigator operationalized imagery as a self-reported response to imaginally encoded concrete and abstract words, comprising phrases on the MIS, and combined ratings to obtain a MS score. Concrete rather than abstract words were stressed, and the images conjured were common though amusing, but not bizarre, although Senter and Hoffman (1976) found that bizarreness does not affect imagery responses. However, scales and correlated performance measures do not evidence the imagining process, which remains a subjective experience of internal mental representations cued by words.

Whether a preferred ideational pattern or characteristic

modal style pervades and enduringly molds behavior and learning, is also conjecturable (Zupnick & Meyer, 1975). Furthermore, if Paivio's (1975) dual-encoding interpretation of the underlying process of imaginal encoding, verified experimentally (Paivio & Crespo, 1973), is applied, then the concrete phrases of the MIS should be replaced by picture items that reflect ideational activity more accurately. In previous interaction research, the negative halo effect of words used as labels to differentiate children has been shown to bias teacher judgments and expectancies, and thus affect intervention (Foster, Ysseldyke, & Reese, 1975). Bracht (1970) also has studied these confounding factors in experiments on aptitude-treatment interactions.

By focussing directly on attentional-input variables (e.g., the investigator's problem of selecting words for scale or test items) Broadbent (1977) has found that common word combinations of neutral emotional tone, and unpleasant words primed by semantic context, intervene differently in the perceptual process, and cue specific constructs with which the testee construes his environment. Accordingly, scale responses may be biased on varyingly global or local (detail) levels, and actively or passively, in ways that markedly alter the preattentive process, and hence coding behaviors. Thus, modality-preference models should account for multiple interaction among different semantic and affective loci and perceptual levels involved in information-processing (e.g., on word or phrase lists), instead of solely attributing response patterns to the effects of ideational or

imaginal style. Without corroborative performance criteria, which measure and reflect these varied input-organizational interactions, sensory-modal scores may indicate largely the testee's unique reactions to the instructional set and stimulus characteristics of the particular scale artifact, and not necessarily represent his schematic imagery and behaviors in concourse with the real everyday world.

Therefore, from the standpoint that the MIS and performance (MLP and MMT) scale data were highly correlated, and demonstrated distinct MS style-and-behavior, the three experiments in the present study provided empirical evidence that the scaling method can (a) analyze imaginal schema and functioning, (b) identify and quantify MS imagery as a specific competence for special education teachers, (c) consistently rank interns on the MS criterion in concordance with ordered performance data, and (d) measure the effects of contrasting treatments. The numerous cited shortcomings of the imagery construct and limitations in its measurement should serve to caution researchers and/or educators to use self-report scales and objective performance ratings, in order to indicate teacher modality patterns and efficacy, only under specific controlled field conditions, as in the current investigation.

Until the dimensions of MS imagery are further explored, and the global-local, active-passive continuum of preattentive perceptual processes is clearly defined, as urged by Broadbent (1977), the present combinative MIS-MLP-MMT method (and instruments) cannot be generalized to other populations and settings. If, as

suggested, MS imagery, planning, and teaching are concomitants of pedagogic expertise, then extensive experimental research of specific MS methods and programs (Smith, 1974, pp. 144-146; Valett, 1974; Reing, Note 3) must be undertaken, to validate further at least one teacher competence.

Consequently, the investigator is engaged in continuing research on the imagery construct, validation of CBTE/C programs, measurement of teacher-competence, standardization of the MIS and correlated performance scales, and derivation of relevant norms for specific groups (i.e., pupils, teachers, and interns). A new MIS version is also being developed involving explicit pictures paired to the 20-item phrases, ergographic correlation, different instructional sets, clinical use to differentiate and predict performance by normal as well as exceptional pupils (Reing, Note 4), and classroom application to task-analyze and prescribe strategies matched to specific learning disabilities (e.g., visual-perceptual dysfunction, dysacusia, dyslexia, dyscalculia, etc.; Reing, Note 1).

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Table 1

Comparison of Scale Characteristics

Scales	Items				Responses	
	n	Format	Presentation	Timing	Type	Scoring
GTCI	125	Words and phrases	Orally read to subjects	Untimed, at tester's rate	1 forced choice among 7	Point tallies
GTCI, Revised	125	GTCI words and phrases	Orally read to subjects	Untimed, at tester's rate	1 rating, 5-0, visual/non-visual	Point tallies
MIS	20	New phrases	Silently read by subjects	untimed, at subjects' rate	6 graphic lines, 0-10 squares	Total[a] of all linear lengths
MIS+	20	Phrases	Silently read	Untimed	6 senses, 10 units	Combined MS total[b]
MLP+	20	Performance criteria	Independent Judges	Untimed	5 levels	
MMT	20			Untimed	5 levels	

Note. The perfect (highest) scores on the combinative scales are: MIS = 724, adjusted 100; MLP = 100; MMT = 100. Abbreviations: n = number of items on each form of the scale; GTCI = Griffitts Test of Concrete Imagery; MIS = Multisensory Imagery Scale; MLP = Multisensory Math Lesson Plan evaluation form; MMT = Multisensory Math Teaching evaluation form; MS = multisensory.

[a]Totals are of all items, on all senses, adjusted by the multiplier (.138).

[b]The combined MS total score is the arithmetic mean of the three scales (i.e., $\frac{[\text{MIS total} \times .138] + \text{MLP total} + \text{MMT total}}{3}$).

Table 2

Results of Field-Testing of Scales

Scales	Subjects				Method		
	n	Age	Source	Condition	Selection	Study, Year	Findings
GTCI	67	12-24	Blind school	Blind, normal	Entire school	Schlaegel, 1953	t = 6.90*
GTCI	78	14-18	High school	Sighted, normal	Random nos.	Schlaegel, 1953	t = 7.43*
GTCI, Rev.	50	15-16	Jr. H.S.	Normal	Random nos.	Reing, 1967	r^1 = +.95**
GTCI, Rev.	212	13-16	Jr. H.S.	HDSA, normal	Random nos.	Reing, 1970	F = 13.37**
GTCI, Rev.	68	18-23	College	Teacher-interns	Entire class	Reing, 1973	r^a = +.91**
MIS	68	18-23	College	Teacher-interns	Entire class	Reing, 1973	
GTCI, Rev.	32	24-42	College	Teachers	Entire class	Reing, 1974	r^a = +.82**
MIS	32	24-42	College	Teachers	Entire class	Reing, 1974	
MIS	16	17-23	College	Male students	Entire class	Reing, 1975	M = 65.06, SD=3.47 SEM = .897
(Sex criteria)	47	17-23	College	Female students	Entire class	Reing, 1975	M = 62.11, SD=11.26 SEM = 1.642 t(61) = 1.017**
MIS (test)	63	17-23	College	Teacher-interns	Entire class	Reing, 1975	M = 62.86, SD=9.96 SEM = 1.265
MIS (retest)	63	17-23	College	Teacher-interns	Entire class	Reing, 1975	M = 75.14, SD=6.49 SEM = .824 F(1, 124) = 66.19** t(124) = 8.13*** W^b = .81**
MIS+ MLP+ MMT	80	18-24	College	Teacher-interns	Entire class	Reing, 1976	F(1, 76) = 23.09** t(76) = 3.96*

Note. Abbreviations: GTCI = Griffitts Test of Concrete Imagery; GTCI, Rev. = Griffitts Test of Concrete Imagery, Revised; MIS = Multisensory Imagery Scale; MLP = Multisensory Math Lesson Plan evaluation form; MMT = Multisensory Math Teaching evaluation form. Total number of subjects tested: pre-MIS = 575; MIS = 301.

[a]Reliability statistic is the coefficient of stability, derived from a Pearson product-moment correlation.

[b]W = Kendall's coefficient of concordance

*$p < .05$; **$p < .01$; ***$p < .001$

Table 3

Cumulative Frequencies, Proportions, and Percentages for MIS

Raw Scores	M	$\bar{M}$ adj.	f	cf	cp	cP (cp X 100)
700-748	724	99.9	12	589	1.000	100
651-699	675	93.2	16	577	.979	97.9
602-650	626	86.4	27	561	.952	95.2
553-601	577	79.6	58	534	.907	90.7
504[a]-552	528	72.9	124	476	.808	80.8
455[b]-503	479	66.1	101	352	.598	59.8
406-454	430	59.3	93	251	.426	42.6
357[c]-405	381	52.6	66	158	.268	26.8
308-356	332	45.8	24	92	.156	15.6
259-307	283	39.1	30	68	.115	11.5
210-258	234	32.3	19	38	.065	6.5
161-209	185	25.6	9	19	.032	3.2
112-160	136	18.8	8	10	.017	1.7
63-111	85	11.7	2	2	.003	.3

Note. The total number of subjects = 589, male and female combined (1/N = .0016977). All raw scores are adjusted by a multiplier of .138. The sum of raw scores = 285761; adjusted = 39435. The mean of raw scores = 485, adjusted = 66.95. The standard deviation = 10.67 and standard error of the mean = .44. Abbreviations: MIS = Multisensory Imagery Scale (used alone); M = mean; $\bar{M}$ adj. = mean x .138; f = frequency; cf = cumulative frequency; cp = cumulative proportion (cf X 1/N); cP = cumulative percentage (cP X 100).

[a] C_{75} (75th centile or third quartile) = 512.74 (raw score). Adjusted C_{75} = 70.75.

[b] C_{50} (50th centile or median) = 460.55 (raw score). Adjusted C_{50} = 63.55.

[c] C_{25} (25th centile or first quartile) = 373.6 (raw score). Adjusted C_{25} = 51.56.

Table 4

Experiment 1: Sex Differences on the MIS

Group	n	M	SD	SE_M	SE_{DM}
Male	16	65.06	3.47	.897	
Female	47	62.11	11.26	1.642	1.017**
Total	63	62.86	9.96	1.265	

Note. Abbreviations: M = mean; SD = standard deviation; SE_M = standard error of the mean; SE_{DM} = standard error of the difference between the means.

**$p > .01$

Table 5

Two-Way Analysis of Variance: MIS Test-Retest (Experiment 2)

Source	df	SS	F
Between X, Y	1	4754.56	66.19***
Within X, Y	124	8907.44	
Total	125	13662.00	

Note. Abbreviations: X = MIS test data; Y = MIS retest data

***$p < .001$

Table 6

Matrix of Mean Differences Using Scheffé Tests: MIS Retest

Group	Means	n	Groups	$\bar{X}-\bar{Y}$	$\bar{X}-\bar{Y}/ET^a$
X	62.86	63	X-Y	12.28	8.13***
Y	75.14	63			
Total	138.00	126			

Note. Significance is one-tailed. Abbreviations: X = MIS test data; Y = MIS retest data.

***$p < .001$

Table 7

Factorial Analysis of Variance (2 X 2): Experiment 3

Source	df	SS	F	(Reversed Means) SS	F
Between lecture, perf. (A_1, A_2)	1	18.05	23.09**	2.45	3.13
Between bowling (B_1, B_2)	1	42.05	53.80**	42.05	53.80**
Interaction (A X B)	1	2.45	3.13	18.05	23.09**
Within groups (1^a, 2^b, 3^c, 4^d)	76	59.40		59.40	
Total	79	121.95		121.95	

Note. Abbreviations : perf. = performance; A_1 and A_2 = lecture (A_1) and performance (classroom training or A_2) conditions; B_1 and B_2 = bowling (B_1) and no bowling (B_2) conditions; A = A_1 + A_2; B = B_1 + B_2.

[a]Group 1 (A_1B_1, or BTL) = bowling, and task-analytic lecture-and-classroom training.

[b]Group 2 (A_1B_2, or TL) = task-analytic lecture-and classroom training without bowling.

[c]Group 3 (A_2B_1, or BT) = bowling and regular lecture only.

[d]Group 4 (A_2B_2 ,or L) = regular lecture only (control group)

** $p < .01$

Table 8

Matrix of Mean Differences Using Scheffé Tests: Experiment 3

No.	Group	Means	N	Nos.	Groups	$\bar{X}-\bar{X}$	$\bar{X}-\bar{X}$/E.T.
1	A_1B_1 = BTL	7.8	20	1-2	BTL-TL	1.1	3.96*
2	A_1B_2 = TL	6.7	20	1-3	BTL-BT	.6	2.16
3	A_2B_1 = BT	7.2	20	1-4	BTL-L	2.4	8.63**
4	A_2B_2 = L	5.4	20	2-3	TL-BT	-.5	-1.80
	Total:	27.1	80	2-4	TL-L	1.3	4.68**
				3-4	BT-L	1.8	6.48**

Note. Abbreviations: TL = task-analytic lecture-and-classroom training; BTL = bowling + TL; BT = bowling program + regular lecture; L (control group) = regular lecture. All groups were in otherwise matched classrooms for internship experience.

*$p < .05$

**$p < .01$

Table 9

Means in Descending Order (Scheffé Tests): Experiment 3

Group	L (4)	TL (2)	BT (3)	BTL (1)
Means	5.4	6.7	7.2	7.8
L		4.68**	6.48**	8.63**
TL			-1.80	3.96*
BT				2.16

Note. Abbreviations: L = regular lecture only (control group); TL = task-analytic lecture-and-classroom training; BT = bowling program + regular lecture; BTL = bowling + TL.

*$p < .05$

**$p < .01$

Figure Captions

Figure 1. Reing's Multisensory Imagery Scale (MIS), a 1974 revision of the Griffitts Test of Concrete Imagery (Reing, 1970; Reing, Note 1). The self-report graphic scale analyzes multisensory ideation. The directions, two sample items, and the first two phrases are presented.

Figure 2. Cumulative percentage or ogive curve for all the MIS scores (N = 589) to date, listed in Table 3.

Figure 3. The Multisensory Math Lesson Plan Evaluation Form (MLP), a numerical rating scale for evaluating multisensory criteria for special education lesson plans prepared by teacher-interns (Reing, Note 1).

Figure 4. The Multisensory Math Teaching Evaluation Form (MMT), a numerical rating scale for evaluating multisensory criteria for special education lessons taught by teacher-interns (Reing, Note 1).

Multisensory Imagery Scale

Directions. How dependent are you, on one or more senses, in imagining your reactions to different, depicted scenes? Each of the following statements briefly describes a vivid experience. Please read carefully, then rate yourself on your initial imagery response by drawing a straight horizontal line next to the sensory question. There are no right or wrong responses, just your own individual preferences. For each of the twenty items, respond to the ideational image that immediately occurs to you, in the six different sensory areas. The longer you draw your line, the more intense is your imagined reaction. The possible responses are:

(a) Visual--Do you see it?
(b) Auditory--Do you hear it?
(c) Olfactory--Do you smell it?
(d) Tactual--Do you feel or touch it?
(e) Gustatory--Do you taste it?
(f) Kinesthetic--Does it make you move toward or away from it?

First, examine specimen items A and B, below, Then, complete all items 1-20.

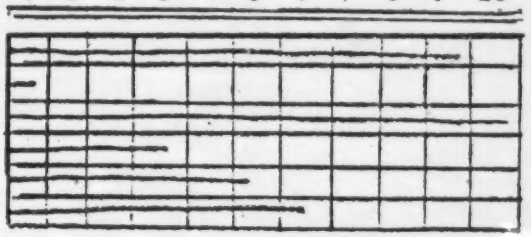
Example

Responses

None → Average → Intense →
0 1 2 3 4 5 6 7 8 9 10

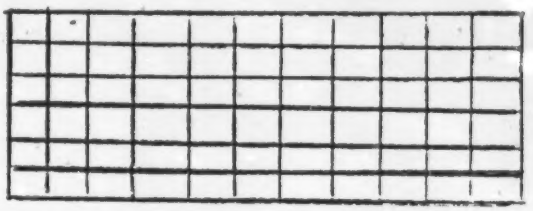
A. Burning cigar

Do you imagine you...
(a) See it?
(b) Hear it?
(c) Smell it?
(d) Feel or touch it?
(e) Taste it?
(f) Move toward or away from it?



B. Steaming chicken soup

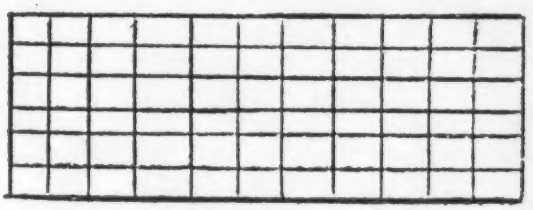
Do you imagine you...
(a) See it?
(b) Hear it?
(c) Smell it?
(d) Feel or touch it?
(e) Taste it?
(f) Move toward or away from it?



Imagery Items

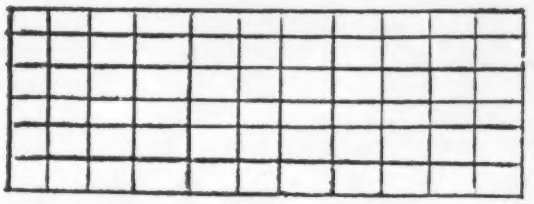
1. Sweaty torn sock

Do you imagine you...
(a) See it?
(b) Hear it?
(c) Smell it?
(d) Feel or touch it?
(e) Taste it?
(f) Move toward or away from it?



2. Sauerkraut on the frankfurter

Do you imagine you...
(a) See it?
(b) Hear it?
(c) Smell it?
(d) Feel or touch it?
(e) Taste it?
(f) Move toward or away from it?



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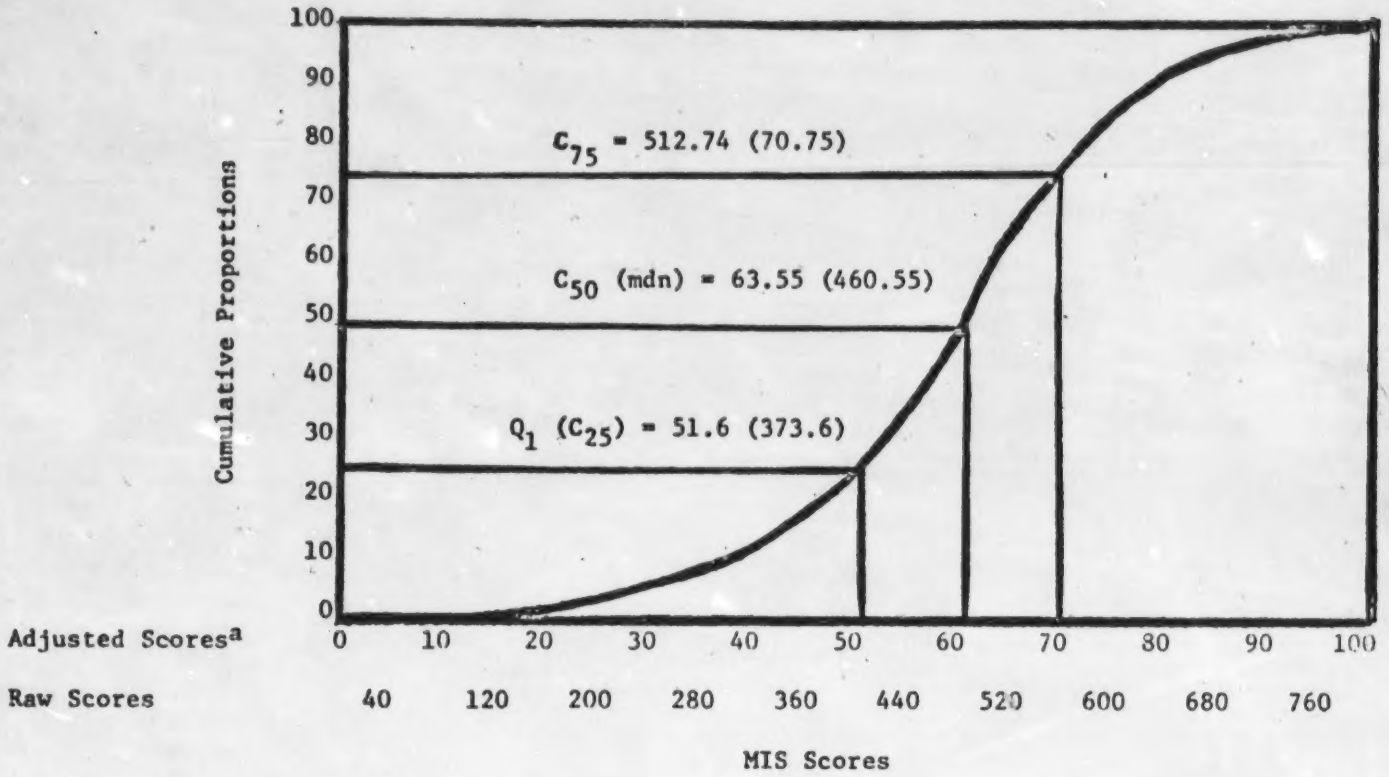
[1]The examiner first reads aloud: "This is a rating scale that shows how you think. It records the senses you imagine you use in response to scenes described to you as you read. There are no right or wrong or best answers. (At the end of the course, you will fill out the same form again. At both times)[a] you score yourselves to see which ways you do most of your imagining--seeing, hearing, smelling, feeling or touching, tasting, or moving. Thus you can learn more about yourselves, (the first step to learning more about the children you teach).[a]

[a]Omit parenthesized sections if inappropriate.



[a]Raw score X .138 = adjusted score

Multisensory Math Lesson Plan Evaluation Form (MLP)

Directions. Listed below are 20 lesson plan criteria. For each item, assign any number from 5 to 0 for each of five different mathematics lesson plans for special education.

Scoring. Rate as follows: 5 = outstanding (A+); 4 = very good (A to B+); 3 = good (B); 2 = fair (C); 1 = poor (D); 0 = unsatisfactory. N.B. Total of averaged scores for criteria (÷5), column A = total of averaged lesson ratings (÷5), column B, and is the MLP score. A perfect MLP score therefore would be 100.

No.	Math-Related Lesson Plans Lesson Plan Criteria	Ratings of Lesson Plans 1	2	3	4	5	Column B Criterion Average (ratings ÷ 5)
1.	Pupil health, safety--control of behavior, setting						
2.	Teacher's aim: curriculum-related, matched to ability/need						
3.	Children's aim; realizable, purposive, objective						
4.	Time control: timing, spacing of content/interaction						
5.	Motivation: interesting materials, presentation						
6.	Questioning technique: inductive and/or deductive						
7.	Pupils' response mode: control, structure, language						
8.	Pupil-participation: involvement, affect, movement						
9.	Realistic objectives: appropriate, pupil-centered						
10.	Teacher role : animation, affect projected, "in charge"						
11.	Activity level : controllable interaction, spontaneity						
12.	Use of materials, furniture, setting, activity structure						
13.	Introduction of lesson: topic clearly stated, understood						
14.	Multisensory methodology: perceptomotor tasks, methods						
15.	Play-game technique(s): varied, imaginative, self-motivating						
16.	Pupil-control methods: positive reinforcement						
17.	Task-relevance : appropriate to curricular/lesson objectives						
18.	Lesson development: logical, connected, sequential						
19.	Realization of objectives : pupil, teacher, curricular						
20.	Method of concluding lesson, leading to next one						
	Column A: Column totals (ratings ÷5)=						Total (1-20) for 5 plans

MLP score

Multisensory Math Teaching Evaluation Form (MMT)

Directions. Listed below are 20 criteria for evaluating multisensory special eduation math lessons taught by teacher-interns. For each item, assign any number from 5 to 0 for each of five different math lessons, for which lesson plans have been submitted.

Scoring. 5 = outstanding (A+); 4 = very good (A to B+); 3 = good (B); 2 = fair (C); 1 = poor (D); 0 = unsatisfactory. N.B. Total of averaged scores for criterion (+5), column A = total of averaged lesson ratings (+5), column B, and is the MAT score. A perfect MMT score would therefore be 100.

No.	Criterion Teacher-Teaching Behaviors	Math-Related Lessons: Ratings of Lessons 1	2	3	4	5	Column B Criterion Average (ratings +5)
1.	Ability to control, direct, guide pupils						
2.	Cooperation with teacher, school, parents, instructors, etc.						
3.	Preparation of lesson: plan, materials, methods						
4.	Acceptance of advice, criticism, differences						
5.	Personality: cheerfulness, stability, warmth						
6.	Knowledge of curriculum: content, objective, rationale						
7.	Conformity to teacher's directions, guidelines						
8.	Concern for pupil's feelings, needs, strengths/limitations						
9.	Rapport with children: acceptance, support						
10.	Rapport with teacher, school supervisors, parents, etc.						
11.	Ability to diagnose learning/behavioral difficulties						
12.	Self-confidence: relaxed, reflective, "cool"						
13.	Ability to match learning tasks to pupils' needs						
14.	Involvement: interest, attitude, responsiveness						
15.	Voice quality, control, animation, sincerity						
16.	Organization: self-control, structure, work-habits						
17.	Appearance: grooming, clothing, facial expression						
18.	Innovativeness: creativity, spontaneity, "oomph"						
19.	Helpfulness: voluntary vs. directed; constructive						
20.	Flexibility: self-correction, willingness to improve						
	Column A: Column totals (ratings +5) =						Total (1-20) for 5 lessons

MMT score